

U.S. Patent Application Serial No. 10/038,875  
Response dated May 19, 2004  
Reply to OA of February 20, 2004

### IN THE CLAIMS

Please cancel claims 4, 5 and 16 without prejudice or disclaimer.

Please amend claims 1, 6, 11, 14, 15, 17 and 26, as follows:

**Claim 1 (Currently amended):** A proton-conducting membrane, comprising a three-dimensionally crosslinked silicon-oxygen structure (A), carbon-containing compound (B), and inorganic acid (C), characterized by ~~wherein~~

a phase-separated structure containing a carbon-containing phase containing at least 80% by volume of the carbon-containing compound (B) and inorganic phase containing at least 80% by volume of the inorganic acid (C), the inorganic phase forming the continuous ion-conducting paths,

wherein said carbon-containing compound (B) is characterized by the skeleton section substituted with hydrogen at the joint with the three-dimensionally crosslinked silicon-oxygen structure (A), satisfying the following relationship:

$$(\delta p^2 + \delta h^2)^{1/2} < 7(\text{Mpa})^{1/2}$$

wherein,  $\delta p$  and  $\delta h$  are the polarity and hydrogen bond components of the three-component solubility parameter.

**Claim 2 (Original):** The proton-conducting membrane according to Claim 1, wherein said phase-separated structure is a sea-island structure with the carbon-containing phase as the island and inorganic phase as the sea.

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**Claim 3 (Original):** The proton-conducting membrane according to Claim 1, wherein said phase-separated structure is composed of a carbon-containing phase and inorganic acid phase both in the form of continuous structure.

**Claim 4 (Canceled).**

**Claim 5 (Canceled).**

**Claim 6 (Currently amended):** The proton-conducting membrane according to Claim 5 1, wherein said carbon-containing compound (B) is bound to the three-dimensionally crosslinked silicon-oxygen structure (A) via 2 or more bonds.

**Claim 7 (Original):** The proton-conducting membrane according to Claim 6, wherein the skeleton section of said carbon-containing compound (B) is a hydrocarbon consisting of carbon and hydrogen.

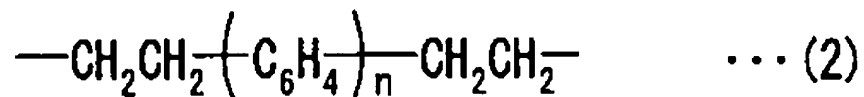
**Claim 8 (Original):** The proton-conducting membrane according to Claim 7, wherein the skeleton section of said carbon-containing compound (B) has the structure represented by the following formula (1):

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wherein, "n" is an integer of 2 to 20.

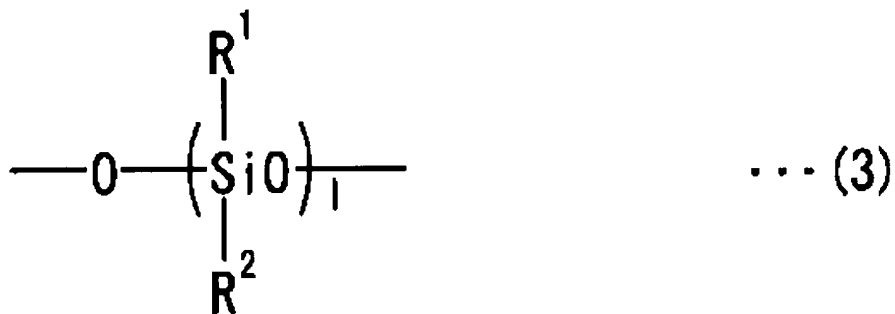
**Claim 9 (Original):** The proton-conducting membrane according to Claim 7, wherein the skeleton section of said carbon-containing compound (B) has the structure represented by the following formula (2):



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wherein, "n" is a natural number of 4 or less.

**Claim 10 (Original):** The proton-conducting membrane according to Claim 6, wherein the skeleton section of said carbon-containing compound (B) has the structure represented by the following formula (3):



wherein, R<sup>1</sup> and R<sup>2</sup> are each a group selected from the group consisting of CH<sub>3</sub>, C<sub>2</sub>H<sub>5</sub> and C<sub>6</sub>H<sub>5</sub>; and  
"1" is an integer of 2 to 20.

**Claim 11 (Currently amended):** The proton-conducting membrane according to Claim # 1,  
wherein said inorganic acid (C) is a heteropoly acid.

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**Claim 12 (Original):** The proton-conducting membrane according to Claim 11, wherein said heteropoly acid is used in the form of being supported beforehand by fine particles of a metallic oxide.

**Claim 13 (Previously Presented):** The proton-conducting membrane according to Claim 11, wherein said heteropoly acid is a compound selected from the group consisting of tungstophosphoric, molybdophosphoric and tungstosilicic acid.

**Claim 14 (Currently amended):** The proton-conducting membrane of according to Claim 4 1, which contains 10 to 300 parts by weight of the inorganic acid (C) per 100 parts by weight of the three-dimensionally crosslinked silicon-oxygen structure (A) and carbon-containing compound (B) totaled.

**Claim 15 (Currently amended):** A method for producing the proton-conducting membrane of any one of Claims 1 to 3 comprising a three-dimensionally crosslinked silicon-oxygen structure (A), carbon-containing compound (B) bound to (A) via a covalent bond, and inorganic acid (C),  
said method comprising steps of preparing a mixture of a carbon-containing compound (D) having one or more hydrolyzable silyl groups and said inorganic acid (C), forming the above mixture into a film, and hydrolyzing/condensing the hydrolyzable silyl group contained in the mixture formed into the film, to form said three-dimensionally crosslinked silicon-oxygen structure (A),

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wherein the skeleton section of said carbon-containing compound having one or more hydrolyzable silyl groups (D) whose hydrolyzable silyl group(s) are substituted by hydrogen satisfies the following relationship:

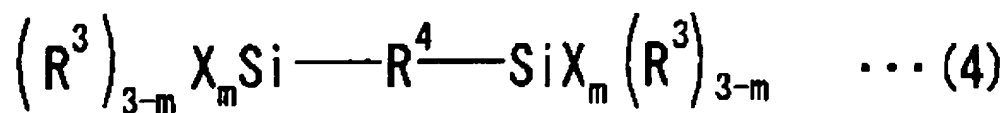
$$(\delta p^2 + \delta h^2)^{1/2} < 7(\text{Mpa})^{1/2}$$

wherein,  $\delta p$  and  $\delta h$  are the polarity and hydrogen bond components of the three-component solubility parameter.

**Claim 16 (Canceled).**

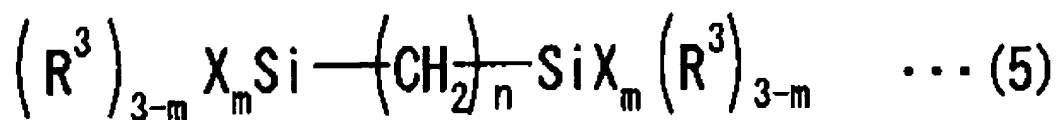
**Claim 17 (Currently amended):** The method according to Claim ~~16~~ 15 for producing the proton-conducting membrane, wherein said carbon-containing compound (D) having one or more hydrolyzable silyl groups has 2 hydrolyzable groups.

**Claim 18 (Original):** The method according to Claim 17 for producing the proton-conducting membrane, wherein said carbon-containing compound (D) having one or more hydrolyzable silyl groups is represented by the following formula (4):



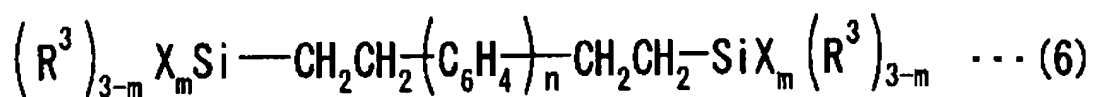
wherein,  $R^3$  is a group selected from the group consisting of  $CH_3$ ,  $C_2H_5$  and  $C_6H_5$ ;  $R^4$  is a hydrocarbon compound consisting of carbon and hydrogen; X is a group selected from the group consisting of Cl,  $OCH_3$ ,  $OC_2H_5$  and  $OC_6H_5$ ; and "m" is a natural number of 3 or less.

**Claim 19 (Original):** The method according to Claim 18 for producing the proton-conducting membrane, wherein said carbon-containing compound (D) having one or more hydrolyzable silyl groups is represented by the following formula (5):



wherein,  $R^3$  is a group selected from the group consisting of  $CH_3$ ,  $C_2H_5$  and  $C_6H_5$ ;  $X$  is a group selected from the group consisting of  $Cl$ ,  $OCH_3$ ,  $OC_2H_5$  and  $OC_6H_5$ ; “ $m$ ” is a natural number of 3 or less; and “ $n$ ” is an integer of 2 to 20.

**Claim 20 (Original):** The method according to Claim 18 for producing the proton-conducting membrane, wherein said carbon-containing compound (D) having one or more hydrolyzable silyl groups is represented by the following formula (6):

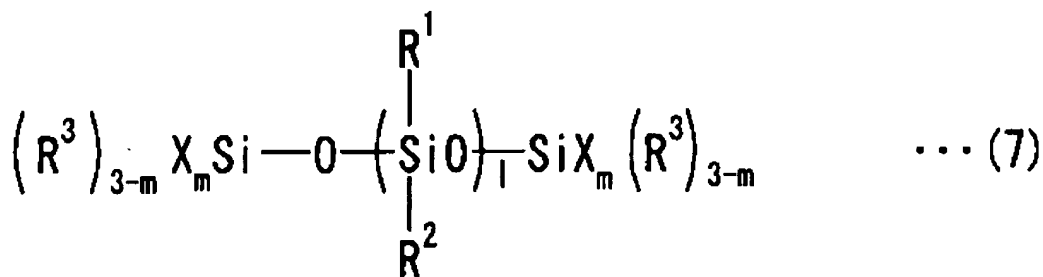




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wherein,  $R^3$  is a group selected from the group consisting of  $CH_3$ ,  $C_2H_5$  and  $C_6H_5$ ; X is a group selected from the group consisting of Cl,  $OCH_3$ ,  $OC_2H_5$  and  $OC_6H_5$ ; "m" is a natural number of 3 or less; and "n" is a natural number of 4 or less.

**Claim 21 (Original):** The method according to Claim 17 for producing the proton-conducting membrane, wherein said carbon-containing compound (D) having one or more hydrolyzable silyl groups is represented by the following formula (7):



wherein,  $R^1$ ,  $R^2$  and  $R^3$  are each a group selected from the group consisting of  $CH_3$ ,  $C_2H_5$  and  $C_6H_5$ ; X is a group selected from the group consisting of Cl,  $OCH_3$ ,  $OC_2H_5$  and  $OC_6H_5$ ; "m" is a natural number of 3 or less; and "l" is an integer of 2 to 20.

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**Claim 22 (Original):** The method according to Claim 15 for producing the proton-conducting membrane, wherein said step of hydrolyzing/condensing the hydrolyzable silyl group to form said three-dimensionally crosslinked silicon-oxygen structure (A) uses water (E) to be contained in said mixture.

**Claim 23 (Original):** The method according to Claim 15 for producing the proton-conducting membrane, wherein said step of hydrolyzing/condensing the hydrolyzable silyl group to form said three-dimensionally crosslinked silicon-oxygen structure (A) is effected at 5 to 40°C for 2 hours or more.

**Claim 24 (Original):** The method according to Claim 15 for producing the proton-conducting membrane, wherein said step of hydrolyzing/condensing the hydrolyzable silyl group to form said three-dimensionally crosslinked silicon-oxygen structure (A) is followed by an aging step effected at 100 to 300°C.

**Claim 25 (Original):** The method according to Claim 15 for producing the proton-conducting membrane, wherein said step of hydrolyzing/condensing the hydrolyzable silyl group to form said three-dimensionally crosslinked silicon-oxygen structure (A) is followed by a step in which a compound (F) having a hydrolysable silyl group is spread and hydrolyzed/condensed, effected at least once.

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**Claim 26 (Currently amended):** A fuel cell which incorporates the proton-conducting membrane of any one of Claims 1 to 3.